

The HIERARCH Keyword Convention

Originally developed and used by ESO

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1 Original ESO Convention

To avoid possible misinterpretations and naming conflicts for keywords describing data acquisition parameters, ESO (the European Organization for Astronomical Research in the Southern Hemisphere) developed a hierarchical keyword convention for this purpose. Under this convention, the FITS keyword name (bytes 1 through 8 of the keyword record) is HIERARCH, and byte 9 contains a space character. Since the HIERARCH keyword does not have the '=' value indicator in bytes 9 and 10 of the keyword record, it is in the same class as the COMMENT and HISTORY keywords that do not have a formal value. Thus, FITS readers that do not support the HIERARCH convention, as described in more detail below, should simply interpret bytes 9 through 80 of the keyword record as containing commentary text.

Under the HIERARCH keyword convention, bytes 10 through 80 of the keyword record contain a series of ASCII strings, or tokens, that serve to hierarchically classify the keyword, followed by an equals sign ("=") which is in turn followed by the keyword value field. An optional comment field may follow the value field, separated by a slash ("/") character. The value and comment fields conform to the rules for free-format keywords, as defined in the FITS Standard document.

The HIERARCH keyword structure is illustrated below:

```
HIERARCH token_1 token_2 ... token_n = value / comment
```

The first token following the HIERARCH keyword name is the 'name space' token, which defines the top level domain of the following tokens. The name space token has the value "ESO" for all the hierarchical keywords defined within that organization; a different unique domain name should be defined by any other organizations that uses this convention. (Currently, it appears that ESO is the only organization that uses this convention).

The other tokens following the name space token and preceding the equals sign character define the hierarchical classification of the keyword. Any number of levels are allowed (as long as they all fit within the 80-character keyword record), but in practice, ESO keywords generally have 3 hierarchical levels which specify the general category, the subsystem, and the parameter name, respectively. For example, in the following keyword:

```
HIERARCH ESO TEL FOCU SCALE = 1.489 / (deg/m) Focus length = 5.36"/mm
```

the domain = ESO, the category = TEL, the subsystem = FOCU, and the parameter name = SCALE.

Under the ESO implementation of this convention, each token string which precede the equals sign conforms to the requirements for a FITS keyword, i.e., be 8 characters or less in length (although a few of the ESO keywords have longer tokens), and be composed only of the uppercase letters A through Z, the digits 0 through 9, and the hyphen and underscore characters.

In some circumstances it may be convenient to map the hierarchical keywords into program variable names by concatenating the hierarchical tokens together, separating them with the full stop character (“.”). For example, the hierarchical keyword shown above corresponds to the variable name ESO.TEL.FOCU.SCALE while the following keyword,

```
HIERARCH ESO INS OPTI-3 ID = 'ESO#427 ' / Optical element identifier
```

corresponds to the variable ESO.INS.OPTI-3.ID. The reverse translation is applied when converting such variables into FITS HIERARCH keywords,

This hierarchical structure provides a convenient and clear way to separate information concerning different subsystems. The definition of FITS keywords used by ESO for data acquisition can be found in the Data Interface Control Document (<http://archive.eso.org/dicb>). This document also gives a full definition of the hierarchical keywords in the ESO name space.

2 Generalized Convention to Support Long Keyword Names

ESO originally developed the HIERARCH convention for the specific purpose of mapping hierarchical descriptor names into FITS keywords. This convention can be easily generalized, however, for other purposes. In particular, this convention can be adapted to support keyword names that are longer than the 8-character limit for a standard FITS keyword, or that contain ASCII text characters that would otherwise be prohibited. Some examples are shown here:

```
HIERARCH LongKeyword = 47.5 / keyword has > 8 characters and mixed case  
HIERARCH XTE$Temp = 98.6 / keyword contains the '$' character  
HIERARCH P.I.Name = 'Will Smith' / Principal Investigator Name
```

Under this convention, the ‘effective’ FITS keyword name begins in byte 10 of the keyword record, and extends up to the position of the ‘=’ character. Any leading and trailing space characters are not significant and are not interpreted as part of the effective keyword name. In principle, any ASCII text character (decimal 32 through 126), except for the ‘=’ character, is allowed in the effective keyword name, however, many non-alphanumeric

characters should be avoided because they may have special meaning in some software environments. Embedded spaces within the keyword name should also be avoided because of possible confusion with the original hierarchical use of this convention. Lower case letters are allowed, but software should be 'case-insensitive' when searching for a specified keyword.

It is recommended that at least 1 space character precede and follow the '=' character that separates the effective keyword name from the value field. The syntax for the value field and the optional comment field in these keywords follows the same rules as for a standard FITS keyword.

In principle, the effective keyword name can be up to 67 characters in length (leaving only 1 character for the value field!), but a more practical limit is about 40 characters. This leaves enough room in the 80 byte keyword record for most keyword values.

This convention should not be used if the effective keyword name can be represented as a standard FITS keyword (i.e., if the name is 8 characters or less in length and consists only of uppercase letters A through Z, the digits 0 through 9, and the hyphen and underscore characters).

This generalized interpretation of the HIERARCH keyword convention is supported by the CFITSIO software library, and was described in a posting to the FITSBITS newsgroup in March 1999 (<http://listmgr.cv.nrao.edu/pipermail/fitsbits/1999-March/000824.html>).